Opening Question: *You are a graphic designer developing a new font. Your current task is to italicize the letter 'N'. If you draw 'N' in $\mathbb{R}^2$, can you create a function to italicize it? Is your function a linear transformation? Will it work for other letters?*

1. You draw the letter 'N' in $\mathbb{R}^2$ and then transform it into *italics*. Viewing each point on the 'N' as a vector in $\mathbb{R}^2$, can you find a linear transformation that moves the vectors to the *italicized* positions?

Regular 'N'   *Italicized* 'N'
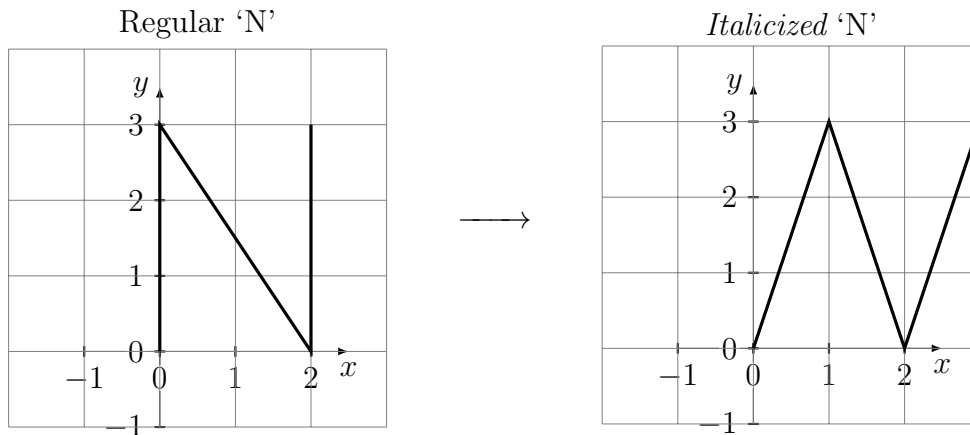
2. Next, you want to take a mirror image of your characters (see below). Using the same approach as before, can you find a linear transformation that does this?

Regular 'N'   Mirrored 'N'
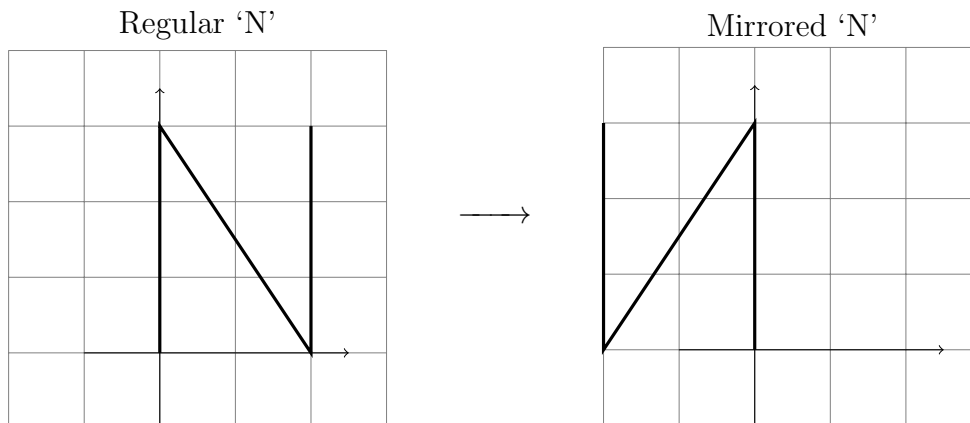
3. Reflect back on #1 and #2 and answer the following questions:

   (a) How do you build the standard matrix of a linear transformation?

   (b) What is the least amount of information we need about what T does to vectors in $\mathbb{R}^n$ before we know what T does to all vectors in $\mathbb{R}^n$?

4. Now, consider the following transformations of the letter 'N'. Which are not possible to achieve by a linear transformation? Change the image as little as possible so that it is the result of a linear transformation.

Starting 'N'   Image #1   Starting 'N'   Image #2

Starting 'N'   Image #3   Starting 'N'   Image #4
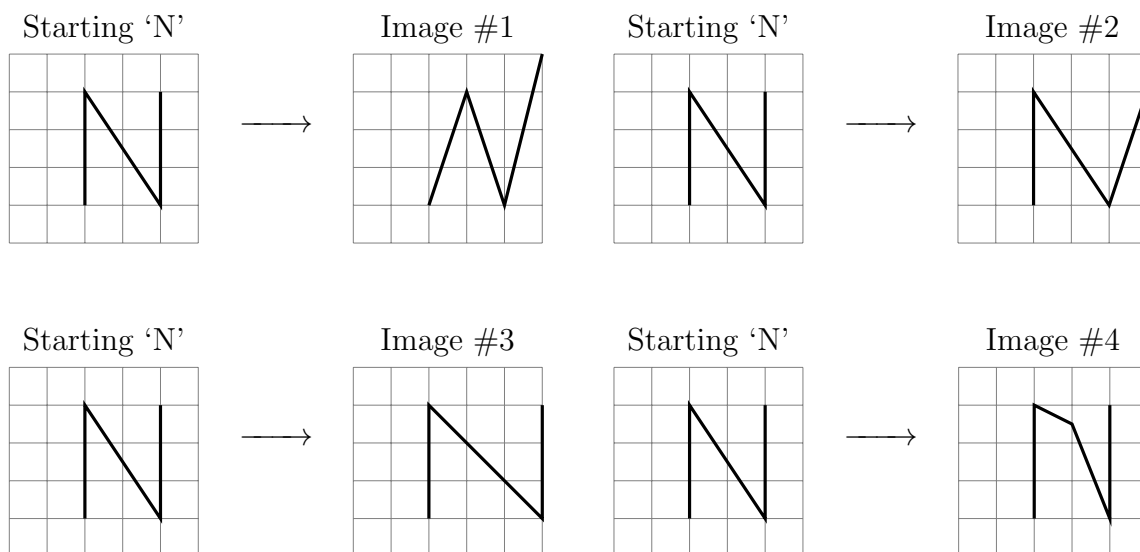
5. Go further:

   (a) What happens when you *italicize* then mirror? What about doing it in the other order?

   (b) If you had a linear transformation from $\mathbb{R}^3 \to \mathbb{R}^5$, what is the minimum amount of information you need to build the standard matrix for the transformation?

   (c) What must a linear transformation do to a line?